On April 9 at 3h. 48m. there is a near approach of 14 Capricorni to the Moon at 339° from the vertex to right, for inverted image.

Phenomena of Jupiter's Satellites

April	h.	m.		April	h.	m.	
5 ...	0	13	I. occ. disap.	7 ...	22	45	III. occ. reap.
	3	26	I. ecl. reap.		23	13	III. ecl. disap.
	21	32	I. tr. ing.	8 ...	2	40	III. ecl. reap.
	23	52	I. tr. egr.		21	34	II. occ. disap.
6 ...	18	40	I. occ. disap.	9 ...	2	29	II. ecl. reap.
	21	55	I. ecl. reap.	10 ..	22	13	IV. ecl. disap.
7 ...	2	28	II. tr. ing.	11 ...	2	37	IV. ecl. reap.
	19	7	III. occ. disap.				

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Saturn, April 5.—Outer major axis of outer ring = 39″·8 ; outer minor axis of outer ring = 18″·1 ; southern surface visible.

April 8, 2h.—Mercury at greatest elongation from the Sun, 19° East.

GEOGRAPHICAL NOTES

A COMMITTEE of the Geographical Society of Vienna has been appointed to carry out the business arrangements of Prof. Lenz's proposed expedition to Central Africa. It is reckoned that 25,000fl. will be wanted for the expedition. At first it was thought that Herr Lenz might go out as the representative of the united Geographical Societies of Vienna, Berlin, and Munich, but the Society of Berlin has decided to send out an explorer of its own, Dr. Fischer, who will start next month. Dr. Fischer will go for the same purpose as Herr Lenz—that is, to explore the watershed of the Upper Congo, and to find traces of the four missing Europeans. But instead of starting from the west coast, as Dr. Lenz proposes to do, he will proceed from the east coast, going from Zanzibar to Uganda.

THE fifth German Geographical Congress (*Geographentag*) will be held in Hamburg on April 9 to 12. Among the points which will be brought before the Congress are the following: Antarctic investigations by Drs. Neumayer and Ratzel; the importance of the Panama Canal to the trade of the world, and deliberations on a new edition of Dr. Neumayer's "Guide to Scientific Observations on Travel." The afternoons will, as hitherto, be devoted to questions connected with school geography. The exhibition directed by Prof. Pagenstecher promises to be especially interesting and exhaustive. It is intended to exhibit new maps, especially in the domain of hydrography, and all the maps and descriptions of the free town of Hamburg and the adjoining districts. The instruments and apparatus used by travellers will be collected in a single group. Rich public and private collections of African and Central American ethnographical and archæological objects will be exhibited, and in part explained by their owners. An exhibit of the products and articles of trade of the various colonies has been rendered possible by the co-operation of large mercantile firms in Hamburg; and zoological, botanical, and geological collections will be so grouped that the character of single countries and continents will readily strike the eye. Some excursions will also be made, especially one to the marshes of the lower Elbe.

WE have received a reprint of a paper recently read before the Philosophical Society of Glasgow by the Rev. Alexander Williamson, the well-known traveller in North China. In the compass of thirty octavo pages the writer describes rapidly the extent, physical conformation, means of intercommunication (especially the rivers, the enormous importance of which is pointed out with much force), the nature of the soil and its products, meteorology, textile fabrics, oil-producing plants, dyes, the geology, trade routes, the race, population, and finally discusses the future. The portions of the subject to which Dr. Williamson devotes especial attention are precisely those which are wholly passed over, or only hastily glanced at in popular works in China. The section dealing with the geology of China gives some remarkable results, based on the investigations of Pumpelly and Richthofen. These show that under every one of the eighteen provinces of China, each of which is about as large as Great Britain, there are large deposits of coal. In some provinces it underlies the whole country in all descriptions—bituminous, anthracite, cannel, and lignite. The extent of these coal-measures may be gathered from the following statement:—Their total area is about 400,000 square miles in China proper. The coal-field in Hunan alone is greater than the aggregate of the coal-fields of the greatest coal-producing countries in Europe; the Shansi coal-field is one and a half times larger than this aggregate, while in other parts of North China we have coal-fields seven times greater than all the coal districts in Great Britain. And, side by side with all the coal-fields investigated, Mr. Pumpelly found iron ores and ironstone of all descriptions. As regards the important geographical and commercial questions involved in trade-routes with South-Western China, Dr. Williamson is in favour of the route from Moulmein through the Shan States, crossing the Chinese frontier into Yunnan at Ssu-mao (Esmok); but he does not despair of the road by the Irrawaddy to Bahmo, and so by Ja-li to the Yang-tse, more especially as the latter would create a trade for itself—viz. that with Sse-chian. Then there is the ancient route between Central Asia and China, which passes through Hinan, Shensi, and Kansu, the southern branch of which leads through Yarkand, Kashgar, and Khoten to India and Persia, and which was used by caravans prior to the Christian era, while the other branch goes in a north-westerly direction to Bar-Kul, Kuldja, and thence to Russian territory.

MR. STANFORD, of Charing Cross, has published a Catalogue of Maps, and other geographical publications, calculated to be of great service to all who may have occasion to inquire after such things. The catalogue covers seventy-two pages, is carefully classified, beginning with maps of the world; after the title of each map is an account of its special features, its size, number of sheets, scale in miles to an inch, and price, according to method of doing up. The Catalogue, we may say, contains the maps of all the leading publishers in Europe. As Mr. Stanford is now sole agent for the Ordnance Survey Maps, a special section of the Catalogue is devoted to this department, and contains a very useful index map.

MESSRS. W. AND A. K. JOHNSTON have also sent us a copy of their new catalogue of the many geographical and other works published by that well-known firm. We have also from the same firm a very excellent wall-map of Egypt, embracing the country down to the south of Lake Victoria Nyanza; it is brought so well up to date as to contain the leading features of Masai Land discovered by Mr. Joseph Thomson's second expedition. Accompanying the map is a useful Handbook of the Geography of Egypt.

THE Arctic ship *Alert*, when returned by the Government of the United States to the Admiralty at Halifax, will be placed at the disposal of the Canadian Government, for the purpose of continuing the exploration in which they are now engaged of the Hudson Bay and Straits.

A COMMITTEE, consisting of members of the Italian Senate and Chamber of Deputies and other influential persons, has been formed at Turin for the purpose of furnishing Sig. Auguste Franzoi with the means of enabling him to carry out his proposal to explore the country between the Abyssinian province of Kaffa and the Lakes of Equatorial Africa.

THE most important paper read before the Paris Society of Commercial Geography at its meeting on the 17th ult. was one by M. Delouell, the explorer of the northern part of the Malay peninsula. He described his discovery of a large lake, during his survey of the isthmus of Krao, called Tabé-Sab, which is bordered by fertile plains, where elephants and buffaloes abound. The people inhabiting this region have hitherto been unknown; they appear to be mestizos, half Siamese, who call themselves Samsams.

AT the last meeting of the Geographical Society of Marseilles M. Brémond read a detailed account, with itineraries, of his travels in the kingdom of Choa.

THE first number for the current year (Band viii. Heft 1) of the *Geographische Blätter* of the Bremen Geographical Society contains papers on the forest districts of Bavaria, the abodes and wanderings of the Esquimaux of Baffin Land, by Dr. Boas, Schwatka's exploration on the Yukon, New Zealand past and present, the German journey of exploration through South America, and numerous smaller communications.

THE last number (Band xx. Heft 1) of the *Zeitschrift* of the Geographical Society of Berlin contains the following papers:—A description by Dr. von Langegg of Old Cairo, situated about four kilometres to the south-west of the Arab quarter of modern Cairo; an account of the mission station of Otyimbingue in Damaraland, by C. G. Büttner; the first part of a discussion

of the methods and task of ethnology, by "Achelis"; a map of the Congo, with accompanying description, by Herr Richard Kiepert; and a note on the additions and changes made in the Chinese administrative organisation of the Thienshan region. The *Verhandlungen* (Band xii. No. 2) of the same Society contains a criticism by Herr Erman, who has for some years had charge of the historical and geographical departments of the Royal Library at Berlin, of the methods in which the work of compiling a bibliography of the geographical works relating to Germany—a "Bibliotheca geographica Germaniæ"—is being carried out.

AT the meeting of the Geographical Society of Paris on March 20, a letter was read from the French Consul at Asuncion in Paraguay, giving details of the expedition sent by the Argentine Government to explore the Pilcomayo, and to ascend to the Bolivian frontier if possible. It has been found that, owing to impassable rapids, the river cannot be utilised as a route between Paraguay and Bolivia. The only practicable route is that by land, the possibility of which was recognised in 1883 by M. Thouar's expedition. M. de Cailland described the Pescadore archipelago in the Formosan channel. The islands have excellent roadsteads, and form the key to Formosa. M. Simonin read a note on the Indian population of the United States; and M. Jules Garnier described his project of an aërial railway for Paris.

A NEW ARRANGEMENT OF THE APPARATUS OF THE ROTATING MIRROR FOR MEASURING THE VELOCITY OF LIGHT[1]

HAVING now been engaged for a number of years in measuring the velocity of light by means of the rotating mirror, I have succeeded in rearranging the apparatus in such a manner as, by means simply of two mirrors, one fixed, the other movable, placed at a distance of a few metres from each other, to obtain, even with a very moderate velocity of rotation, a deviation of the image of a fixed object as large as may be desired in theory and limited in practice only by the intensity of the light and the perfection of the optical apparatus.

To describe in a few words the plan of L. Foucault's celebrated experiment:—The rays issuing from a narrow aperture fall, at a distance of 1 m., on a rotating mirror 14 mm. in diameter, and, on being reflected there, traverse an object-glass placed as near the mirror as possible. This object-glass throws an image of the aperture on a spherical concave mirror having a radius of 4 m. placed at a distance of 4 m. from the rotating mirror. A second mirror, in all respects perfectly corresponding with the first, receives the reflected pencil, which produces a fixed image of the rotating mirror, and transmits a movable image of the aperture to a third mirror, and so on. Foucault's apparatus comprised five similar mirrors. The last, in which a fixed image was formed, reflected on the fourth the light, which retraced its previous course and so came back to the rotating mirror, which again in turn transmitted it deviated in respect of its rotation by an angle twice as large as that at which it had turned when performing the double passage of the mirrors, *i.e.* twice 20 m. The velocity of rotation being 400 revolutions per second, Foucault obtained a deviation of 7 mm.

One of the objections taken to Foucault's experiment and the values he deduced from it respecting the velocity of light, is the smallness of that deviation. It is known how he ingeniously cleared the difficulty by substituting for the measurement of the deviation that of the distance of the aperture from the rotating mirror producing a determined deviation. He did not, however, disguise the fact that the advantage of this substitution is perhaps more specious than real, and he brought forward the plan of an apparatus composed of a series of objectives and of a concave mirror, by means of which the passage of the light might be extended to several hundreds of metres. He had even selected, at the Observatory, the place where his new experiments might be carried out.

I have to confess that, in endeavouring to take advantage of Foucault's scheme, whether by means of object-glass or of mirrors, I struck on such difficulties as caused me to desist from the prosecution of my researches by either of the methods indicated.

In the United States in 1879 Mr. Michelson put in operation the experiment of the rotating mirror at great distances, but under an arrangement which brings the experiment much nearer to the celebrated one of MM. Fizeau and Bréguet than that of Foucault. The aperture from which the light issues was placed at a distance of about 30 English feet (9·15 m.) from the rotating mirror, the diameter of which amounted to 1¼ inches (3·2 cm.). A simple non-achromatic lens, 7 inches (17·8 cm.) in diameter, and having a focus of 150 feet (45·75 m.) was placed in such a manner as to throw an image of the aperture, seen by reflection in the rotating mirror, on the surface of a plain mirror, 7 inches in diameter, placed normally to the line passing through the centres of the two mirrors and the lens, at a distance of 1986·23 feet (605·80 m.) from the rotating mirror. The pencil then returns on itself, and gives an image of the aperture coinciding with it, point for point, when the mirror is fixed, deviated as soon as it rotates. The lineal displacement of the image during a rotation of 258 revolutions per second amounted to 114·15 mm. The advantage, however, of such a large displacement seems to be counterbalanced by the inferior quality of the image. A lens 7 inches in diameter, and with a focus of 150 feet will, even under the best conditions, necessarily give an image bounded by very large fringes of diffraction, which atmospheric agitations transform into a luminous blot so ill-defined that, as Mr. Michelson himself confesses, it is impossible to study the effect of the parallax due to the defect of coincidence of the plane of the image with that of the lines of the micrometer; in other words, there is no defined focus.

In all my experiments, therefore, it has been my aim to maintain the perfect accuracy of optical effects, such as had been achieved by Foucault, believing that it is of greater advantage to measure even the small deviations of a perfect image than the exaggerated displacement of a blot of light. I have consequently sought to amplify the deviations of Foucault without increasing the distance to be traversed by the light, and without having recourse to great velocities of rotation on the part of the mirror.

I call to mind, by the way, that Bessel noted, as a means of increasing the deviation, the return of the deviated ray on the rotating mirror. This method, which has never yet been applied, might be utilised by means of a series of little plain mirrors placed in couples on one side and the other of the rotating mirror, in such a way as to transmit the pencil alternatively on one and the other of the two parallel faces of the rotating mirror. With each reflection the deviation increases by a quantity equal to its primitive value.[1] But this process would greatly complicate the measurement of the path traversed by the light. The advantage contemplated by it may, besides, be secured by a method much more elegant and simple.

The apparatus I bring under the notice of the Academy consists purely of two mirrors, one fixed, having a diameter of 0·20 m., the other movable, 0·05 m. in diameter, the two placed at a distance of 5 m. from each other. Both are concave and spherical, and have the same radius of curvature, 5 m. The source of light is a narrow aperture cut in the silver, in the centre of the large mirror. The pencil emanating from it and entirely covering the rotating mirror is reflected by the latter, and returns to form on the surface of the fixed mirror a movable image of the aperture and of the same size. In each of its positions this movable image becomes a source of light; the rays return to the movable mirror, which concentrates them anew into a fixed image: this is the image of Foucault, which coincides with the aperture when the rotation is very slow, which is deviated in respect of the rotation when the latter is a little rapid. Suppose the velocity of the rotating mirror to be such that the lineal deviation is equal to the breadth itself of the aperture, the image will then come to be formed on the fixed mirror, rim to rim with the aperture itself. There it falls on the reflecting surface of the silver, becomes then a source of light exactly similar to the first, producing a second image deviated by the same quantity. The latter in its turn acts like the first, in such a manner that, if one could look on the surface of the fixed mirror, one would there be able to see, issuing from the aperture itself, an indefinite series of identical images placed rim to rim and indistinguishable from each other, except in respect of their regularly increasing brightness. If the velocity of rotation is increased, all these images will be found to separate from each other and form on the fixed mirror a series of equal luminous lines, separated by equal intervals from each other, and

[1] Paper, by M. C. Wolf, in the *Comptes Rendus* for February 9.

[1] These plain mirrors, disposed in couples, might also be used to collect and transmit in one constant direction the light scattered in all directions by the rotating mirror. By this means the advantage would be obtained of observing the doubled deviation of a much more brilliant image.